New Measurements, Data Assessment, and Correlation of the Viscosity of Sulfur Hexafluoride

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Sulfur Hexafluoride has been identified as a possible standard reference fluid for sealed capillary viscometers. Its near-critical properties have been studied under microgravity but wide-ranging viscosity data for the fluid are scarce. Like CO_2, sulfur hexafluoride has a very narrow vapor-liquid coexistence region. Its molecular structure is a model for hexafluorides of heavier elements which are more difficult to measure.

New viscosity measurements on this fluid were carried out in the low-temperature torsional crystal viscometer from the triple point to supercritical conditions with pressures up to 35 MPa. The instrument was operated in two measurement modes. The well-established mode of determining the fluid viscosity from mechanical spectroscopy in the frequency domain served as a reference to test the newly developed mode where the viscosity is deduced from the free decay of the crystal vibration in the time domain. The results validate this first quantitative implementation of the free-mode measurement over a wide range of conditions from dilute gas to compressed liquid.

The measured viscosities provide a basis for comparison of the somewhat discordant literature data at high densities. While there are deviations of up to 7.5% between results from different laboratories, predictive models underestimate the viscosity of sulfur hexafluoride by up to 33% in the range of the present measurements. A new correlation was developed which includes the correct zero-density limit, the Rainwater-Friend second viscosity virial coefficient, and a free-volume term for the high density range. It represents the selected data with an expanded relative uncertainty of ±2%.